

REMARKS

This preliminary amendment is filed to illustrate the statement disclosed in page 16, lines 4-6 of the specification that "an embodiment of the propulsion apparatus described with electrical drive can be used with an internal combustion engine". The embodiment disclosed in additional drawings and relative changes in the specification is a combination of an outboard engine 10 shown in FIGS. 1, 4a, 4b and a planetary gearbox 59 with four propelling means 82, 83, 84, 85 shown in FIGS. 8, 9, 10.

There are no new features in this preliminary amendment that are not disclosed in the originally filed specification or are not commonly known and are not the subject of this invention. That is why no new matter has been added in this preliminary amendment.

It is simply an additional illustration that will help better understand this invention.

FIG. 7 is a vertical cross-sectional view along line VII-VII in FIG. 5.

FIG. 8 is a schematic perspective view of an embodiment of the propulsion apparatus mounted on the transom of a watercraft.

FIG. 9 is a horizontal cross-sectional view along line IX-IX in FIG. 8.

FIG. 10 is a vertical cross-sectional view along line X-X in FIG. 8.

FIG. 11 is a vertical cross-sectional view along line XI-XI in FIG. 8.

FIG. 12 is a schematic perspective view of another embodiment of the propulsion apparatus mounted on the transom of a watercraft.

FIG. 13 is a view along arrow E in FIG. 12.

FIG. 14 is a view along arrow F in FIG. 12.

FIG. 15 is a vertical cross-section along line XV-XV in FIG. 12.

The identical details in all the drawings have the same designations.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIGS. 1, 2 and 3a, an outboard internal combustion engine 10 is mounted in a conventional manner on the transom 11 of a watercraft 12 with ability to be pivoted around a vertical axis 13 and a horizontal axis 14. A gearbox 15 mounted on the engine case extension 16 encloses a conventional bevel gear drive including a pinion bevel gear 17 which is fixed on the engine shaft 18 and is engaged with one of two driven bevel gears 19 or 20. A horizontal driving shaft 21 is mounted in the bearings 22 and 23 and is disposed transverse to the advancement direction of the watercraft 12. The bevel gears 19, 20 are keyed on the driving shaft 21 so that they can be moved along its axis to engage or disengage with the pinion bevel gear 17 for changing the direction of rotation of the driving shaft 21.

Two identical planetary gearboxes 24 and 25 are mounted on both sides of the gearbox 15. According to the preferred embodiment of this invention, each of the planetary gearbox has a cylindrical housing 26 with a central hub 27 which is fixed on the horizontal

-6a-

shaft 21. A cover 28 is secured to the cylindrical housing 26 by fasteners (not shown) and is mounted rotatably on the extension 29 of the gearbox 15. There is a sealing element 30 between the cover 28 and the extension 29. Each of the planetary gearboxes 24, 25 encloses a planetary bevel gear engagement comprising a sun bevel

allow the terminal leads of the electric coils 94. The outer periphery of the protrusions 93 faces the inner periphery of the permanent magnets 90 across a small air gap 101. The inner stators 91, 92 generate a rotating electromagnetic field enabling to rotate the planetary gearbox 59 through the outer rotors wherein the casings 86, 87 work like a kind of hollow driving shafts.

During the operation, the planetary gearbox 59 is rotated in the direction of an arrow R. The propeller blades 82a, 83a, 84a and 85a are constrained by the planetary gearbox 59 to rotate simultaneously around the axis of the support rod 60 and around the axes of the radial output shafts 73, 74, 75, 76 of the planetary gearbox 59 with the same rotational speed. The propeller blades adjacent to each other in the perpendicular planes are rotated in opposite directions (clockwise and counter-clockwise) not interfering with each other. After each 90 degrees of rotation of the gearbox 59, two propeller blades are oriented substantially downwards and are plunged into the water for exerting the propulsive force, while the other two propeller blades are disposed substantially horizontally over the water level.

During each turn of the planetary gearbox 59, four propulsion strokes are exerted which follow consecutively one after another. Each propulsion stroke is exerted by two propeller blades 82a, 83a or 84a, 85a. Both sides of the blades are used consecutively as working surfaces. During backward movement astern, the propeller blades are always oriented substantially perpendicular to such movement exerting the propulsion force propelling the watercraft. The forward moving propeller blades are always oriented in the plane of such movement with minimum resistance in the water. When the orientations of the blades are changing from the horizontal to the downward position, the circumferential velocity of their rotations around the axis of the driving shaft is increased.

FIGS. 12-15 illustrate an embodiment of the transverse watercraft propeller wherein two such planetary gearboxes having four propelling means on each of them are mounted on an outboard internal combustion engine 10 in a manner similar to those shown in

FIGS. 1, 4a, 4b. The identical details in all the drawings have the same designations.

An outboard internal combustion engine 10 is mounted in a conventional manner on the transom 11 of a watercraft 12 with ability to be pivoted around a vertical axis 13 and/or a horizontal axis 14. A gearbox 15 is mounted on the engine case extension 16. As shown in FIG. 15, a horizontal driving shaft 21 is mounted in the bearing 22, 23 and is disposed substantially transverse to the advancement direction of the watercraft 12. In this embodiment, worm gear engagement is used in the gearbox 15 for rotating the driving shaft 21 in the direction of arrow R. A worm gear 102 is mounted on the shaft 21 and a worm 103 is rotated by the output shaft of the engine 10 (not shown). However, those skilled in the art understand that any other gear engagements can be used for rotating the horizontal shaft 21, for example, such as a bevel gears engagement shown in FIGS. 4 and 5.

Two identical planetary gearboxes 59 and 59' are mounted on both sides of the gearbox 15, each of them including a housing 63 with a central hub 64 and a cover 65.

The housing 63 encloses a planetary bevel gears engagement similar to the gears engagement shown in FIGS. 9 and 10 which includes a sun bevel gear 68, two planet bevel gears 77, 78 and four identical engaged bevel gears 69, 70, 71, 72 mounted on the radial output shafts 73, 74, 75, 76. Each of the radial output shafts is mounted in two bearings 79, 80 and extends through the sealing elements 81 in the housing 63. Four propelling means 82, 83, 84, 85 are affixed to the ends of the radial output shafts 73, 74, 75, 76, respectively, and disposed with extensions in opposite directions perpendicular to the radial output shaft similar to those shown in FIGS. 8-10. The propelling means 82, 83, 84, 85 include the propeller blades 82a, 83a, 84a, 85a which are balanced by a counter-weight 82b, 83b, 84b, 85b, respectively, relative to the axes of the radial output shafts. The planetary gearboxes 59, 59' are filled with a lubricating oil.

In a preferred embodiment of such a propulsion apparatus shown

in FIG. 15 the sun bevel gear 68 is mounted on a hollow support means 104, which is fixed to the gearbox 15 and extends into the housing 63 through a sealing element 105 in the cover 65 of the planetary gearbox. A shaft 106 is mounted in two bearings 107 and 108 and is connected with the driving shaft 21 by a coupling 109. The housing 63 of the planetary gearbox 59 is fixed to the shaft 106 by a pin 100.

As shown in FIGS. 12-14, the identical planetary gearboxes 59 and 59' are mounted in positions turned on the axis of the driving shaft 21 substantially 45 degrees relative to each other.

In operation, the planetary gearboxes 59, 59' are rotated by the driving shaft 21 in the direction of arrow R. Simultaneously, the propelling means are constrained by the gear engagement to rotate around the axes of the radial output shafts of the planetary gear boxes 59 and 59'.

The driving shaft 21 can be disposed both over the water level or under the water level.

While this invention has been described with reference to the structures disclosed herein, they are merely chosen and described to illustrate the principle, applications, and practical use of the invention to thereby better enable others skilled in the art to

utilize this invention. The preferred embodiments of the present invention illustrated in FIGS. 1-15 are not confined to the details as set forth and are not intended to be exhaustive or to limit the invention to the precise form disclosed. For example, an embodiment of the propulsion apparatus described with electrical drive can be used with an internal combustion engine or any other type of drive. The invention is intended to cover any modifications, which may be variously practiced within the scope of the following claims or their legal equivalents, rather than by examples given.